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Technical Memorandum

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		Date:	January 25, 2001

Project: Gorst Creek Landfill, Operations and Maintenance
Contract Number: N44255-98-D-4409 Delivery Order: 0020

Subject: Gorst Creek Hydrologic Modeling

This memorandum present the results of hydrologic modeling performed to estimate peak flows and runoff volumes from the Gorst Creek watershed upstream of State Highway 3 in Kitsap County, Washington.

Background

Gorst Creek is a small, ungauged tributary to Sinclair Inlet in Kitsap County, Washington. The Gorst Creek Landfill is located in a ravine just upstream of the State Highway 3 culvert crossing about 3 miles southwest of the town of Gorst (Figure 1). The drainage basin upstream of the highway crossing encompasses approximately 162 acres (0.25 square miles). For the purposes of this analysis, the basin upstream of the highway was divided into two sub-basins. Land use in the lower sub-basin consists of about 118 acres of mostly undeveloped, forested land, with the exception of an auto wrecking yard east of the stream channel that occupies about 16 acres (~ 9 %) of the basin. Land use in the upper sub-basin (east of SW Sunnyslope Road) consists of approximately 43 acres of low-density residential development.

The landfill essentially forms a small dam on Gorst Creek. Flow is conveyed underneath the landfill through a single 24-inch-diameter, corrugated metal culvert. It is currently thought that the culvert is either crushed or clogged with debris. Alternatives being considered to prevent upstream flooding or overtopping of the landfill include the construction of a bypass structure to re-divert Gorst Creek through or around the landfill.

Gorst Creek is an intermittent stream upstream of the highway crossing, and discharge data are presently not available. For this reason, standard hydrologic modeling techniques were used to provide a reasonable estimate of peak discharges and runoff volumes that could be used in the design of a bypass structure.

Modeling Methods

Because the Gorst Creek watershed is relatively small, the U.S. Army Corps of Engineer's HEC-1 model was used in lieu of a more complicated continuous simulation model. Hydrographs for the basin upstream of the highway crossing were generated for the 2-, 5-, 10-, 25-, 50-, and 100-year, 24-hour SCS type IA synthetic design storms. The storm "types" were developed by the SCS to describe the temporal distribution of rainfall over the duration of the storm. Four distributions were developed for four geographic regions within the United States. In Washington, the storm types 1A and II have been designated for western and eastern parts of the state, respectively.

Basin physical characteristics and land uses were determined from digital mapping obtained from Kitsap County. Basin soil types were obtained from the *Kitsap County Area Soil Survey* (SCS, 1981) and were used to determine the hydrologic groups of basin soils. In the HEC-1 model, the relationship between rainfall and runoff can be expressed as a curve number. An area-weighted curve number was developed to account for different runoff characteristics of the upper sub-basin, the auto wrecking yard, and the lower sub-basin.

The time parameter used in the HEC-1 model is the SCS lag time, which is proportional to the time of concentration by a factor of 0.6. The time of concentration is a measure of the time required for the entire watershed area to contribute to runoff. This was estimated using methods presented in the Washington State Department of Transportation *Highway Runoff Manual* (WSDOT, 1995). Rainfall depths were obtained from NOAA's precipitation frequency maps for Washington State (NOAA, 2000). The key hydrologic variables used in the model are presented below in Table 1. The complete input file is attached.

Table 1
KEY HYDROLOGIC VARIABLES FOR MODEL

BASIN CHARACTERISTICS	VALUE
Basin Area	0.25 sq. miles
Area-weighted Curve Number	75
Time of Concentration (Lag Time)	1.4 hour (0.82 hour)
Rainfall Distribution	SCS Type 1A, 24-hr duration

Modeling Assumptions

Assumptions made with respect to the Gorst Creek HEC-1 model include:

- No routing was performed from the upper sub-basin to the lower sub-basin through the existing 36-inch culvert. Reasonably accurate survey data immediately upstream of the culvert are necessary to define a stage-storage relationship.
- A future diversion structure will replace the existing landfill culvert, so the model did not include the existing 24-inch landfill culvert.

Modeling Results and Discussion

Results of the HEC-1 model runs are presented in Table 2 and hydrographs are plotted in Figure 2.

Table 2
SCS TYPE 1A DISTRIBUTION, 24-HOUR DURATION

Recurrence Interval	Rainfall Depth (in)	Peak Flow (cfs)	Total Runoff Volume (ac-ft)
2-yr	3.0	16	13
5-yr	3.7	28	20
10-yr	4.2	38	25
25-yr	5.0	55	33
50-yr	5.5	66	39
100-yr	6.0	77	45

Notes:
in = inches
cfs = cubic feet per second
ac-ft = acre-foot

The peak flows listed above are likely to be conservative (i.e., worst-case) estimates because in SCS methodology, the time of concentration is calculated assuming all runoff occurs via surface flow. The model thus shows much of the total runoff arriving at the basin outlet quickly, resulting in high peak flows. The actual time of concentration may be much longer as rainfall infiltrates into the soil and emerges later as interflow and seepage. Performing a separate model run routing flow from the upper to the lower sub-basin would also probably yield smaller numbers as a result of flow attenuation at the road culvert.

The estimates of runoff volumes are probably less conservative, as there is no dependency on time parameters. This information may be useful if detention of some proportion of the total runoff is desired.

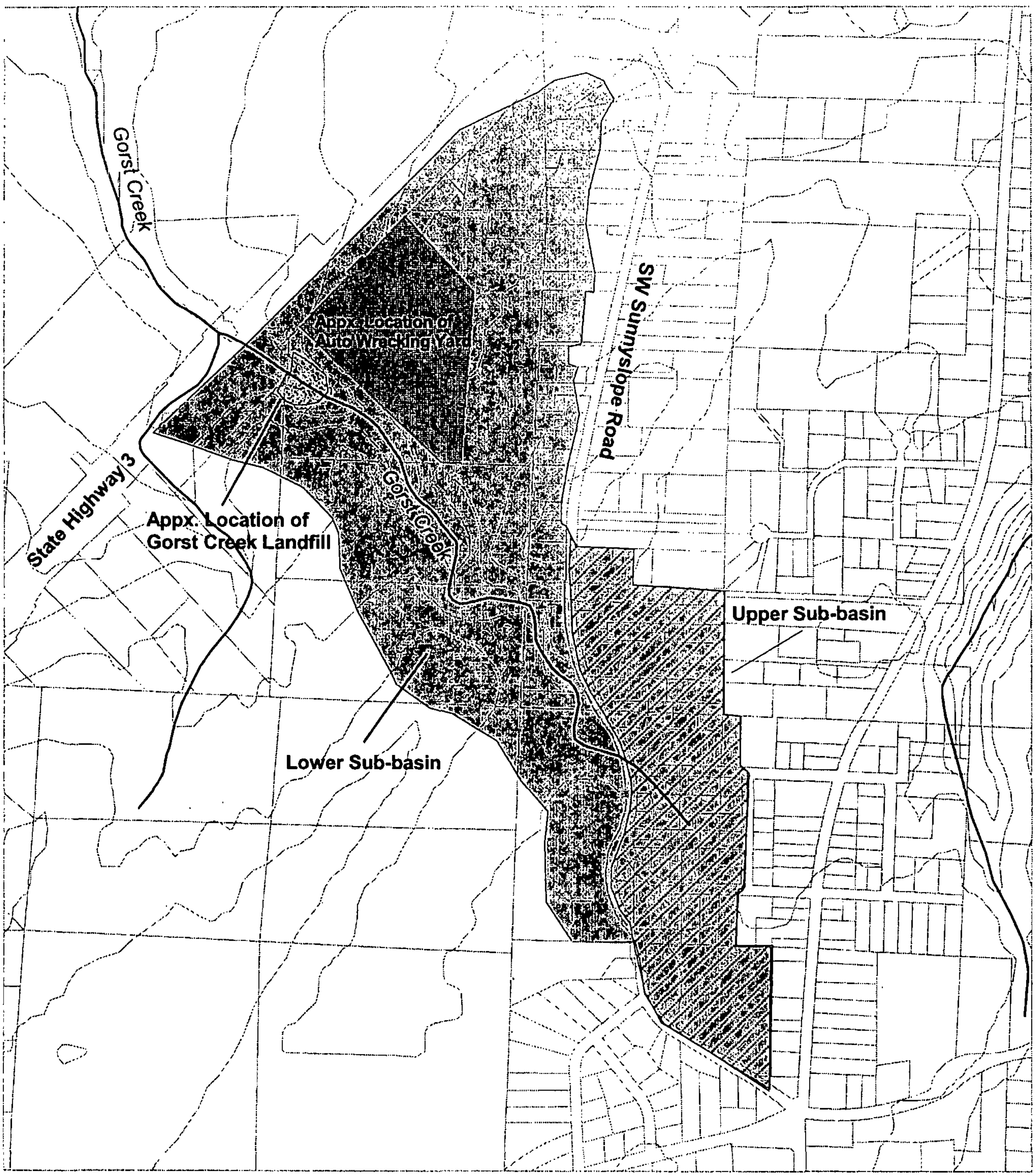
Because the total basin area is small, relatively large errors in peak flow estimates are likely to be of little consequence in terms of the overall project cost of a diversion facility. (Pipe conveyance increases with the square of the diameter, and pipe costs will probably be small compared to other project costs). For this same reason, there is little practical value in attempting to validate the above results from a comparison to a similar, gauged basin.

References

NOAA web site. *Washington Precipitation Frequency Maps* (2000)

USDA Soil Conservation Service. *Kitsap County Area Soil Survey* (1981)

Washington State Department of Transportation. *Highway Runoff Manual* (1995)



Legend

- Lower Sub-basin
- Upper Sub-basin
- Streams
- Parcel
- Contour
- Auto Wrecking Yard
- Landfill

Figure 1
Gorst Creek Basin

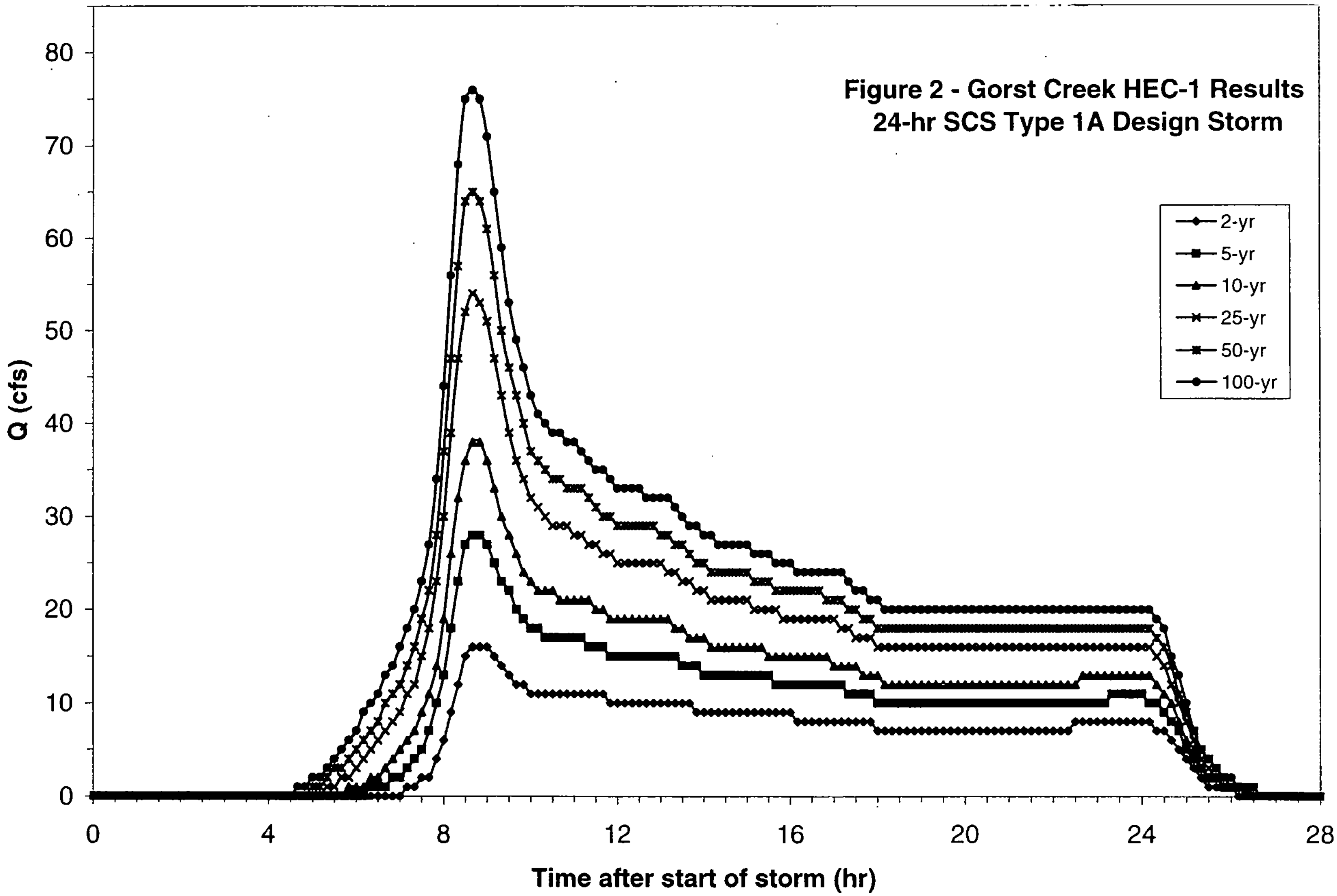


Figure 2 - Gorst Creek HEC-1 Results
24-hr SCS Type 1A Design Storm
2-yr
5-yr
10-yr
25-yr
50-yr
100-yr
Q (cfs)
0
10
20
30
40
50
60
70
80
0
4
8
12
16
20
24
28
Time after start of storm (hr)

HEC-1 Input File

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ID       Kitsap County, Gorst Creek
ID       2, 5, 10, 25, 50, 100-YR, 24-HOUR TYPE IA STORM
ID       10-minute time step
IT    10 01JAN90    0000     300
IO     1
JR  PREC     3.0     3.7     4.2     5.0     5.5     6.0
*
KK Entire
KM   Runoff from Entire basin
BA  0.25
IN    10 01JAN90    0000
PB     0
PC 0.000   0.004   0.008   0.012   0.016   0.020   0.024   0.028   0.032   0.036
PC 0.040   0.045   0.050   0.055   0.060   0.065   0.070   0.076   0.082   0.088
PC 0.094   0.100   0.106   0.113   0.120   0.127   0.134   0.141   0.148   0.156
PC 0.164   0.173   0.181   0.189   0.197   0.207   0.216   0.226   0.235   0.245
PC 0.254   0.268   0.281   0.294   0.312   0.330   0.364   0.418   0.445   0.463
PC 0.477   0.490   0.504   0.512   0.521   0.530   0.539   0.548   0.556   0.565
PC 0.574   0.583   0.592   0.600   0.609   0.616   0.624   0.631   0.638   0.645
PC 0.652   0.660   0.667   0.674   0.681   0.688   0.696   0.701   0.707   0.713
PC 0.718   0.724   0.730   0.736   0.741   0.747   0.753   0.758   0.764   0.769
PC 0.774   0.779   0.784   0.789   0.794   0.799   0.804   0.809   0.814   0.819
PC 0.824   0.828   0.832   0.836   0.840   0.844   0.848   0.852   0.856   0.860
PC 0.864   0.868   0.872   0.876   0.880   0.884   0.888   0.892   0.896   0.900
PC 0.904   0.908   0.912   0.916   0.920   0.924   0.928   0.932   0.936   0.940
PC 0.944   0.948   0.952   0.956   0.960   0.964   0.968   0.972   0.976   0.980
PC 0.984   0.988   0.992   0.996   1.000
BF  0.00    0.00
LS          75.0
UD  0.82
*
ZZ
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